

**DIGITAL INTERACTIVE SYSTEM FOR PROVIDING FULL INTERACTIVITY
WITH LIVE PROGRAMMING EVENTS**

RELATED APPLICATIONS

This application is a continuation of application Serial No. 08/815,168, filed March 11, 1997, which is a continuation-in-part of application Serial No. 08/598,382, filed February 8, 1996, which is a continuation-in-part of application Serial No. 08/443,607, filed May 18, 1995, which is continuation-in-part of application Serial No. 08/166,608, filed December 13, 1993, now abandoned, which in turn is a continuation of application Serial No. 07/797,298, filed November 25, 1991, now abandoned.

BACKGROUND OF THE INVENTION

Interactive video and audio presentation systems are currently being introduced into the entertainment and educational industries. A prominent interactive technology that has been applied successfully in these industries is based on providing interactivity in a one-way system through the provision of multiple time-synched parallel channels of information. For example, commonly owned Freeman et al. patents, U.S. patent nos. 4,264,925 and 4,264,924, which provide both

audio and video interactivity, disclose interactive television systems where switching among multiple broadcast or cable channels based on viewer selections provides an interactive capability.

These systems have been enhanced to include memory functions using computer logic and memory, where selection of system responses played to the viewer are based on the processing and storage of subscriber responses, as disclosed in Freeman patent, U.S. patent no. 4,507,680.

The benefits of providing interactivity through the use of different audio responses is disclosed in Freeman, U.S. patent nos. 4,847,698, 4,847,699 and 4,847,700. These television systems provide a common video signal accompanied by several synchronized audio channels to provide content related user selectable responses. The audio signals produce different audio responses, and in some cases, these are syllable synched to a first audio script and to the video signal (such as to a person or character on a display), providing the perception that the person's or character's mouth movements match the spoken words.

Interactivity is brought to the classroom in the Freeman U.S. patent no. 5,537,141. The distance learning system claimed in this application enhances the classroom educational experience through an innovative use of interactive technology over transmission independent media. When an instructor, either broadcast live on video or displayed from videotape, asks a question, each and every student responds, preferably by entering a response on a remote handset, and each

student immediately receives a distinct and substantive audio response to his or her unique selection. The individualization of audio response from the interactive program is a major aspect of the invention.

Individualization of audio is brought to the home based on the technology disclosed in Freeman U.S. patent no. 5,585,858. This system provides a program that can be watched on any conventional television set or multimedia computer as a normal program. But if the viewer has a special interactive program box connected to the television, he or she can experience a fully functional interactive program. Each interactive viewer enjoys personalized audio responses and video graphics overlaid on the screen. The interactive program can be provided to television sets or to computers by cable, direct broadcast satellite, television broadcast or other transmission means, and can be analog or digital.

However, what is needed is an interactive presentation system for providing true video, audio and graphics interactivity with digital programs broadcast live. Such a system must efficiently package all the digital elements of the live interactive program at a centralized control studio and allow viewers at home to receive personalized interactive programming.

SUMMARY OF THE INVENTION

In accordance with the invention, there is provided an interactive digital system allowing the viewer active participation in selecting digital video streams,

associated with different camera angles, for example, and integrated audio and/or graphics segments. Further, Web pages from Internet Web sites can be integrated into the program. The invention is particularly suited for the environment of live events, such as the broadcast of live sporting events. The viewer can appear to direct the camera shots by instantly changing among various camera angles, choose player interviews, or display associated statistical data on the team or players via graphics. In this manner, the system allows the individual subscriber to act as if he or she has control over how the program is directed and presented on their personal television set. In addition to selecting different camera angles, various audio options, closeups, slow motion, replays, graphics overlays, graphics or audio from Web sites, etc., are all possible. Further, games can be integrated with the live sports programming to increase viewer interest.

Thus, viewers can customize the content of programs. The interactive digital programming of the present invention is particularly advantageous for viewing live sporting events. Viewers are not limited to selecting from multiple camera angles, but may also call up player statistics on demand, listen to selected player interviews, etc. Cameras can be focused on different segments of an event. Further, video options could include video replay, slow motion effects, isolation on a particular player or group, etc. Changes are seamless, thereby adding to the effect that the viewer is directing the television show just as a director now does from a control room.

This "director" role by the viewer is possible due to the interactive technology of the present invention and also due to the digital compression and transmission scheme which allows for much greater information throughput over a given bandwidth, allowing viewers to choose from angles that are already available but presently cut by the director.

The digital interactive system is based upon branches which occur in the course of the full-motion video. Branches are real-time parallel paths that may be other full-motion video segments, graphics which are integrated into the video, audio segments, and/or retrieved Web pages which are integrated into the live event.

Sometimes, the interactive digital system will act upon the viewer's response immediately; other times, it will utilize ACTV's unique "profiling" concept to act upon the response later. This technology enables the system to "remember" the viewer's responses and desires, and integrate them into the video, audio, graphics and/or Web site information at a later point. For example, the viewer could specify at the beginning of a football game to isolate the offensive quarterback of a particular team. Thus, whenever the team of choice is on offense, the video isolation of the quarterback is displayed to the viewer automatically. Or, based on how a viewer has selected camera angles, replays, etc., over the past five minutes, the system acts to mimic these selections at later times during the program. The system of the present

invention "learns" from the viewer how they want to view the game, and thus, continues viewer selection sequences made earlier.

At the source, the present invention comprises a plurality of video cameras, each of the video cameras relaying a different predetermined view of an event. The video signals corresponding to the different cameras are forwarded to a central control studio. Further, one or more audio signals or graphic statistical overlays can be collected and sent to a central control studio. After receiving the video, audio, and graphics signals at the central control studio, these signals are digitized and compressed in digital video and audio compressors. These signals are then combined with special data codes into a "digital package," and subsequently, transmitted over a cable distribution system. The special data codes are the keys to unlocking the interactive potential of the program.

The digital program signals are transmitted to a receive site by any suitable transmission means. Once received by a receive antenna, the digital program signals are passed along on a digital cable television distribution system to the viewer homes. Further, some other signals or commercials can be inserted at the local head end. The signals are received and processed in a digital cable box. Selections of the video, audio, graphics display and/or Web pages can be made as a function of immediate viewer entries, or to interrogatory responses presented at the beginning or during the program, or based on a prestored viewer profile. Once a

decision is made to switch from one video option to another video option, the digital switch is performed seamlessly.

As mentioned above, the program at predetermined times or immediately upon user entry can retrieve and branch to informative segments from Web sites. For example, a viewer watching a sporting event, through the system of the present invention, can receive a stream of Web pages which provide additional, specific information relating to a favorite player, team or perhaps the remaining schedule for the sports team, as examples. In addition, users can take advantage of the two-way capabilities of the Internet to respond to polls or to link to additional sites.

Another Internet-based application allows advertisers to speak more directly to consumers by directly sending Web pages to the consumer instead of merely displaying Web addresses in their commercials. The particular advertising information from Web sites can be targeted to viewers based on the viewer profile, stored either in the digital set top box or at the cable headend. Alternatively, Web site access can be initiated by the viewer by simply clicking on the remote during the commercial. Thus, viewers have the capability to individually select Web sites if they want more information from advertisers, for example.

The video programming and corresponding Internet pages can be viewed either on personal computers equipped with a television card on special digital cable boxes with stored interactive Internet application software providing Internet access,

or on digital television sets, all of which would utilize the specialized TV/Internet software of the present invention.

The present invention also has applications for other types of programming. For example, viewers can direct the scenes of a murder mystery. Switching from one scene to another can be done seamlessly without noticeable effect on the viewer. Further, the present invention can be used for any kind of live or pre-recorded event. For instance, a music concert or a political convention can be enhanced in the manner of the invention.

Accordingly, a primary objective of this invention is providing an enhanced digital live program allowing the display to be tailored to the user's desires, choices or interests.

It is an object of this invention to personalize and enhance live sporting events for the viewer.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a diagram of the network and equipment for providing live digital programming.

Figure 2 is a block diagram of an interactive digital cable box allowing seamless switching between video signals.

Figure 3 is a block diagram of an alternative dual-tuner interactive digital cable box allowing seamless switching between video signals.

Figure 4 is a block diagram of another alternative interactive digital cable box allowing seamless switching between video signals.

Figure 5 is a time diagram showing a representation of trigger points and corresponding video, audio and/or graphics segments, one or a combination of which are selected for presentation to the subscriber immediately after the execution of the trigger point function.

Figure 6 is a block diagram of an alternative embodiment of the interactive system including Internet access.

Figure 7 is a block diagram of the two-way configuration of the system.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention is an interactive digital system 1 for producing a powerful personalized program allowing the home viewer an expanded set of programming options. Digital TV streams are put into digital packages made up of video, audio, data codes and graphics, and are used to provide personalized responses to viewer selections. Such responses can be further enhanced by allowing access to Internet Web sites 170. In this manner, sports such as golf, football, baseball, basketball, etc. can now be watched with greater interest and involvement. However, even further enhanced interactivity is possible with the present invention due to the provision of various profiling and memory features.

As shown in Figure 1, the present invention begins with the gathering of several possible video streams by way of cameras 100, strategically located at a sporting event 10, for example. Currently, many cameras 100 are employed at a sporting event 10. Super Bowl coverage, for example, typically encompasses 25 to 30 cameras. These live video streams can be integrated with recorded video streams which, for example, could include highlights from the current game or past games, player profiles, etc. To describe the components and operation of the present invention, the production and transmission of a live sporting event 10, i.e., football, is chosen to present the invention features. However, other applications can be appreciated by the reader, including several disclosed below.

A. The Control Studio

The interactive broadcast program is prepared at the control studio 5 into digital packages. The control studio 5, as shown in Figure 1, allows a producer to create and introduce interactive elements during a live broadcast. In one preferred embodiment, the producer pre-records a set of interrogatories or instructions for the user. These interrogatories may include such questions as the following:

SELECT THE CAMERA ANGLES/OPTIONS THAT YOU PREFER:

OPTIONS:	END-ZONE
	FIFTY YARD LINE
	FOCUS ON THE QUARTERBACK
	FOCUS ON THE DEFENSE

FOCUS ON THE CHEERLEADERS
PROVIDE HIGHLIGHTS

WHO IS YOUR FAVORITE TEAM IN THE GAME?

OPTIONS: BLUE TEAM
 RED TEAM

WHO IS YOUR FAVORITE PLAYER IN THE GAME?

OPTIONS: RED RUNNER
 BLUE QUARTERBACK
 BLUE DEFENSIVE END
 RED QUARTERBACK
 ETC.

ARE YOU INTERESTED IN RECEIVING STATISTICAL SUMMARIES?

WOULD YOU ENJOY LISTENING TO PLAYER INTERVIEWS DURING THE
GAME?

Such interrogatories can be presented to the viewer at the beginning of the broadcast or scattered throughout the program. Interactive responses to such interrogatories would include video, audio and graphics personalized to the particular viewer. The preparation of the graphics for presenting such interrogatories occurs off-line at the control studio 5 using chyron or any graphics language. These interrogatories or instructions will ultimately be displayed to the home viewer, preferably in the form of graphics, to facilitate the interactive responses. The producer creates these graphic video slides of questions on a computer using the text editor and chyron. Associated with each question, the producer enters a number of possible viewer options. Then, the producer relates each possible user entry to one or more corresponding interactive responses. If the

response is information from an Internet Web page, the producer will indicate the particular Uniform Resource Locator (URL) of the Web page. The producer sets a time stamp for when each particular question will appear during the program. As explained below in more detail, the viewer response to a query will be used to direct which video (and/or audio, graphics, or Web page) option will be provided to the viewer. In the present invention, the interactive response to the query can occur immediately following the entry of the viewer entry or at some predetermined later time in the program using "trigger points," 500 as explained in detail below.

With respect to the video segments, cameras 100 are preferably trained on different segments of the sporting event 10. As is common with broadcasts of a football game, for example, cameras 100 could be located in the endzone, press box, the field and at various other locations throughout the stadium. Further, various video options can be created including video replay, slow motion, isolation on cheerleaders, particular player or group of players. Instant replays are created by delaying the live feed for a certain number of seconds. These video streams are sent to a control studio 5. The control studio 5 contains the necessary equipment for packaging the program for delivery to the viewers. The studio 5 contains a video switcher 105 which receives the live signals from the cameras 100 by way of various input lines. Further, lines carrying recorded video streams from one or more VCRs 110, computers or CD players feed into the video switcher 105. The video switcher 105 also receives video inputs from the control computer 135. Further, various

graphics screens, depicting, for example, sports team or player statistics can be designed with the control personal computer 135 and forwarded to the digital video switch 105. The producer, via the control PC 135, directs which video options to pass through the video switcher 105. At the output of the video switcher 105, each of the different output video streams access a separate encoder 125 and are all GENLOCKED, so that each video stream is synchronized with the other video streams.

After encoding, the video streams are input into a video compressor 125. Preferably, the digital compression scheme is MPEG-2. Preferably, 64 Quadrature Amplitude Modulation (QAM) is used as the modulation scheme. In this digital embodiment, four channels of digitally-compressed video content would carry about 27 Mbps using 6 MHz of bandwidth. Alternatively, if 256 QAM is employed, seven-to-one video compression can be achieved with the MPEG-2 scheme. While MPEG-2 is the preferred compression scheme, the signals can be compressed according to any known standard including MPEG-1, JPEG, or other DCT coding scheme, wavelets, fractals or other transform or waveform based technique.

The control studio 5 also contains an audio switcher 115 which receives live audio signals from microphones or recorded audio from tape players 120, CDs, VCRs 110, etc.. The control computer 135 sends commands to the audio switcher 115 directing which audio options should pass through the switch 115. Further, in the audio switcher 115 the various audio signals can be aligned to match the various

video signals in time. In addition, VCR audio output is received by the audio switcher 115. The present invention can accommodate any number of audio signals as output from the audio switcher 115, as directed by the producer. The audio outputs are received by an digital audio encoder/compressor 130. The audio signals are then preferably sampled, encoded and compressed in the digital audio encoder/compressor 130. The encoding technique can be a waveform coding technique such as PCM, ADPCM or DM. Alternatively, the signals can be encoded using synthesizer or vocoder techniques such as MUSICAM, Linear Predictive Coding (LPC), Adaptive Predictive Coding (APC), and Sub-band coding. Generally, the transmission rate is about 256 kbps per audio for the stereo pair.

The timing and control for integrating the various multimedia elements is provided by the ACTV authoring language, a unique set of interactive data codes to facilitate the interactive process. The data codes are stored in memory in the control computer 135 as part of the ACTV programming language. The codes comprise commands, or branch codes, for branching between interactive options, timing signals for controlling the interactive program, data or text, commands for termination and initiation or interactive program viewing, or triggers for executing macros. Preferably, these commands are output from the control computer 135 and multiplexed with the video streams in the MPEG-2 compressor 125, as shown in Figure 1. Interactive options that can be branched to based on the branch codes

include video segments, audio segments, graphics segments and/or identified Web pages.

There are several commands in the ACTV authoring language that function to provide the interactive sports programming applications. These commands are explained below in Section D, which details programming applications.

B. The Transmission System

As shown in figure 1, the digital interactive system 1 uses an interactive program delivery system with any transmission means including satellite 15, cable 150, wire or television broadcast 175 to deliver the interactive program (hereinafter "composite interactive program") from the control studio 5 for distribution to subscribers in their homes. At the control studio 5, the signals from the digital multiplexer 140 are converted to RF and distributed to a microwave 175, cable 150 or satellite 15 network. Preferably, the digital interactive signal is forwarded from the control studio 5 to a cable headend 150, and subsequently, sent to the homes via the cable network.

The program is preferably the broadcast of a live event. For example, live sporting events with added interactive elements can be broadcast from the control studio 5. Such live interactive elements could be different camera angles 100, slow motion video, etc., as discussed above, while also incorporating prerecorded

interactive segments such as highlights. Alternatively, the program can be produced off-line and stored in a program storage means at the control studio 5.

In a satellite broadcast transmission, the digital interactive signals are transmitted to uplink equipment where they may be multiplexed, upconverted, modulated, amplified and transmitted by satellite 15 to the receiver site 155 for distribution to the homes.

At the reception end, the composite digital interactive signals enter a receiver 155 where the signals are demultiplexed, downconverted, demodulated and then passed to a cable distribution system that directs the signals to the homes. Although a cable distribution system 150 is the preferred transmission media to the homes, the digital signals may also be distributed by any conventionally known technique including satellite 15 to digital satellite receivers 155 at the home, fiberoptics, low or high power broadcast television 175, telephone lines, cellular networks, and similar technology can be used interchangeably with this program delivery system.

C. The Interactive Digital Box

The interactive digital box 25 is shown schematically in Figure 2. Preferably, the interactive digital box is a specially adapted digital cable box 25. The controller 260 determines what video, audio, graphics and/or Web pages to display based upon the interactive commands which it receives. Based upon the commands, it plays the appropriate video, audio, graphics or Web page options. The graphics can either

be created and sent from the control studio 5 or the graphical images can be created at the interactive digital box 25 based on instructions preferably in the interactive commands. The interactive digital box 25 connects to a television 165 or other display monitor. Further, the interactive digital box 25 can be connected to a digital television 195, in which case an RF modulator 245 is not necessary. Each downstream transmission reaches the subscriber's house, shown in Figure 2, preferably through a tap and drop cable.

The user interacts with the program through the input device 20. Preferably, the input device 20 is a typical television remote. The user interface 270 may be an infrared, wireless, or wired receiver that receives information from the input device 20.

Regardless of the type of input device 20, user inputs can be utilized by the present invention immediately, or at a later time, to result in personalized graphics, video and/or audio presentation. For example, the present invention utilizes "trigger points," 500 as described below, to enable subsequent branches among multimedia segments during the show.

Certain commands are sent from the control studio 5 as part of the digital interactive programming to facilitate the collection of user entries. These commands are extracted at the digital demultiplexer 210 and sent to the controller 260 which performs the appropriate action based on the commands. Some of these commands are explained below.

a. **BEGIN INPUT EXTENDED**

The Begin Input command starts an input period during which the user may press one or more buttons to select his or her choice(s). The entry format of this command is set forth as follows:

BEGIN INPUT {{N} {VALID KEYS} {DIFFERENT} {FEEDBACK}}

where:

N The maximum number of keys that can be pressed.
KEYS The valid keys that can be pressed.
DIFFERENT Requires each key pressed to be different.
FEEDBACK The feedback type provided to the viewer.

b. **BEGIN VIDEO CHOICE EXTENDED**

The Begin Video Choice begins an input period for disco mode. During disco mode, the video switches dynamically each time the viewer makes a selection.

BEGIN_VIDEO_CHOICE MODE [KEYS] {FEEDBACK [AUDIO]}

The disco mode allows the viewer to change channels at will, while the OneShot mode allows only one change of channel.

MODE DISCO/ONESHOT
KEYS The valid keys that can be pressed.
FEEDBACK The feedback supplied to the user for the key(s) which are pressed.

The mode Disco allows the viewer to change channels at will, while the OneShot mode allows only one change of channel.

c. *BEGIN AUDIO CHOICE EXTENDED*

The Begin Audio Choice begins an input period for disco mode.

BEGIN_AUDIO_CHOICE MODE [KEYS] {FEEDBACK [AUDIO]}

MODE DISCO/ONESHOT

KEYS The valid keys that can be pressed.

FEEDBACK The feedback supplied to the user for the key(s) which are pressed.

d. *MAP*

The Map command is used to map video or audio tracks to keys, for use in connection with the Begin Audio Choice and Begin Video Choice commands. If this command is omitted, Key 1 will map to Track or Channel 1, Key 2 to Track or Channel 2 etc. This command allows mapping any key to any channel.

MAP KEYS [TRACKS [T1,...TN/T1-TN] CHANNELS [C1,...CN/C1-CN]]

The map statement maps audio tracks or video channels to keys, to enable audio or video choice commands to effect changes to tracks other than the default tracks, which are that key 1 maps to track 1, key 2 to track 2, etc.. All the choice statements after a map statement will cause the tracks, video tracks or channels to be changed to those specified in the map statement. The acceptable numbers for the map command are from 1 to 8, for keys, video channels and audio channels.

Other commands include those which allow for the following applications:

- (1) viewer profiling, to enable the set top box 25 to "remember" viewer preferences;
- (2) uploading viewer responses to a central location; (3) downloading of text and graphics, for display using the graphics chip of the set top box 25; (4) the ability of the

viewer to prepare his own video, based upon his selections of camera shots 100 and audio, which can be stored and replayed for the viewer.

The interactive digital box 25 of the present invention enables seamless flicker-free transparent switching between the digital video signals. "Seamless" means that the switch from one video signal to another is user imperceptible. Because the video signals are running off the same clock, the interactive digital box 25 is capable of providing a seamless digital switch from one video signal to another signal. The program clock reference necessary for the box to make this seamless switch is preferably embedded in the signal header.

As shown in Figure 2, a CPU 260 is connected to an RF demodulator 200 and digital demultiplexer 210. The CPU 260 directs demodulation and demultiplexing of the proper channel and data stream to obtain the correct video signal. Seamless switching can occur with MPEG-2 compressed signals since there are points within the frame wherein seamless switching can occur. Preferably, switches occur at an "I" frame, assuming the use of MPEG-2 compression. The selected video signal is determined either by examination of the user's input from user interface 270 and/or any other information or criteria (such as personal profile information) stored in RAM/ROM 265. For example, the RAM/ROM 265 could store commands provided within the video signals as discussed in U.S. patent no. 4,602,279, and incorporated herein by reference.

The RF demodulator 200 demodulates data from the broadcast channel directed by the controller 260. After the data stream is demodulated, it passes through a forward error correction circuit 205 into a digital demultiplexer 210. The demultiplexer 210 is controlled by the controller 260 to provide a specific video signal out of a number of video signals which may be located within the data stream on the demodulated broadcast channel. The demultiplexed video signal is then decompressed and decoded by decompressor/decoder 215. The video signal is synchronized by a sync add circuit 220 and a sync generator 225. The video signal is then buffered by a video frame buffer 230. The buffered video signal is modulated by a modulator 245 into a NTSC compatible signal. Such a modulator is not necessary if the selected signal is sent to a digital television 195.

By using a video frame buffer 230 and delaying the viewing of a given signal, enough time is allowed for the decompressor/decoder 215 to lock onto, decompress, convert to analog, and wait for the resultant vertical interval of a second video signal. For example, assume video signal A is currently being processed and transferred through the circuit shown in Figure 2 and displayed. Based upon a user selection, the controller 260 directs the digital demultiplexer 210 and RF demodulator 200 to switch to another video signal, video signal B. To accomplish this, the analog video from the first digital video signal, video signal A, complete with video sync, is fed into video frame buffer 230. This buffer 230 can hold the full video picture for "n" number of frames after which the signal is output to the

display. In effect, a delayed video signal A is viewed "n" number of frames after the signal has been received. When the user selects a different video path by means of pressing a button on a keypad or entry by other means, the controller 260 instructs the digital demultiplexer 210 to stop decoding signal A and lock onto signal B to begin decoding signal B instead of signal A.

While this is happening, even though the decompressor/decoder 215 is no longer decompressing video signal A, the display is still showing video signal A because it is being read from the buffer 230. As soon as decompressing and decoding occurs, the controller 260 looks for the next vertical blanking interval (VBI) and instructs the video frame buffer 230 to switch to its input, rather than its buffered output at the occurrence of the VBI.

Since the RF demodulator 200, forward error corrector 205, digital demultiplexer 210, and decompressor/decoder 215 require a certain time period to decompress and decode the video signal B frame from its data stream, the size of the buffer 230 has to be large enough so that this processing can take place without interruption during the switching of the video signals. If desired, the system may continue to use the buffer in anticipation of a future switch. By using the controller 260 to manipulate the fill and empty rate of the buffer 230, the buffer 230 may be rapidly filled with video signal B frames and then after a period of time will be reset and ready to make another switch to another video in the same manner. The buffer 230 may also be reset by skipping frames or providing a delay between sequential

frame outputs for a short time in order to fill the buffer 230. If a delay is used to maintain video signal or frame output while the buffer 230 is being filled, a slight distortion may occur for a brief amount of time.

Because a first video signal is always displayed as the output of the buffer 230 after the delay, the buffered video masks the acquisition and decoding of a second video signal. As long as the buffer 230 is large enough to keep the first video running while the second video is being decompressed and decoded, a seamless switch will occur.

While the digital interactive box 25 of Figure 2 provides video interactivity, audio and/or graphics interactivity is also provided. For example, if, based on the viewer profile or viewer response to query, it is determined that the viewer's primary language is Spanish, then that viewer could obtain Spanish commentary to the football, soccer, etc. game. Alternatively, if a viewer has a favorite athlete, the audio can switch to an interview with the athlete during a segment of the broadcast. Multiple digital audio options forming a set of suitable responses to an interrogatory message can be sent as part of the composite digital signal. As set forth in U.S. patent no. 5,585,858, herein incorporated by reference, there are a number of different ways to effectively forward the necessary audio options for a given live event to the digital interactive box 25. With the present invention, it makes no difference how the audio options reach the digital interactive box 25, as long as they are available for selection and play at the appropriate times.

In Figure 2, the digital demultiplexer 210 extracts the digital audio signal(s) and forwards them to the audio switch 250. Additional audio options are available from the digital audio memory 255. At certain times during the program, the data codes will identify the selection of a particular audio option corresponding to previous user inputs. The controller 260 calls the appropriate audio options from internal memory 255 or directs the audio switch 250 to select a predetermined audio segment received as part of the received digital signal for passage to the RF modulator 245 for play to the subscriber. At the end of the audio segment time period as indicated by the data codes, the controller 260 instructs the audio switch 250 to again pick up standard audio.

The digital demultiplexer 210 sends the extracted graphics data or ACTV data codes to the controller 260. The controller 260 interprets the extracted data as either control data, including instructions for switching between video signals, audio signals, or graphics data for on-screen display. If the data is on-screen display data, the data is preferably prefixed by a command designating the data as on-screen display data, as opposed to control data. Further, the controller 260 also examines the control data for the occurrence of a header code designating the onset of a trigger point 500 in the program, explained below.

Figure 3 shows an alternate, dual tuner embodiment for seamless switching between separate video signals. This embodiment presumes that two 6 MHz channels are used, each of which comprises compressed digital video and audio

streams. In this embodiment, the microprocessor 260 controls the selection of the RF channel that is demodulated by RF demodulators 200A, 200B. The demodulated data streams enter the forward error correctors 205A, 205B. At the output of the forward error correctors 205A, 205B the data streams are transmitted to the input of the digital demultiplexers 210A, 210B.

As with the RF demodulators 200A, 200B, the digital demultiplexers 210A, 210B are controlled by the microprocessor 260. This configuration allows the microprocessor 260 to independently select two different individual time-multiplexed video signals on different channels and data streams. If all the video signals of an interactive program were contained on a single channel or data stream, it would only be necessary to have a single RF demodulator 200, forward error corrector 205, and digital demultiplexer 210 serially connected and feeding into the two digital video buffers 230A, 230B.

Two data streams are provided from the digital demultiplexers 210A, 210B. One data stream carries video information pertaining to the video signal the user is currently viewing. The second data stream carries the video signal selected based on the user's previous and/or current interactive selections from the user interface 270, as determined by the microprocessor 260.

The digital information on each of the two streams is buffered in digital video buffers 230A, 230B. The buffered signals are then decompressed and converted into

analog signals by decompressors/decoders 215A, 215B which include digital to analog converters. The decompressors 215A, 215B are preferably MPEG-2 decoders.

A local sync generator 225 is connected to sync add 220A, 220B and frame sync 380A, 380B circuits. Because both streams are synchronized based on signals from the same local sync generator 225, each stream becomes synchronized to the other. In particular, the signals on each stream are frame synchronized.

A vertical blanking interval (VBI) switch 335 is connected to the microprocessor 260 so that the input may be switched during the vertical blanking interval of the current stream, resulting in a seamless switch to the viewer.

The embodiment of Figure 3 operates as follows. Based on user responses and control codes, it is assumed that the microprocessor 260 determines that a switch from video signal A to video signal C should be performed. The RF demodulator 200A and digital demultiplexer 210A are processing the currently viewed video signal, video signal A, which is progressing through the upper branch components. A command is issued from the microprocessor 260 to the RF demodulator 200A, 200B commanding a switch to the channel and data stream on which video signal C is located. The microprocessor 260 also instructs the digital demultiplexer 210B to provide video signal C from the received data stream to digital video buffer 230B.

At this point, the upper RF demodulator 200A and digital demultiplexer 210A are still independently receiving and processing video signal A, which continues through the upper branch of the circuit.

At a certain point, the digital decompressor/decoder 215B in the lower branch will begin filling up with video signal C frames. After video signal C is decompressed and decoded, it is converted into analog. A local sync generator 225 inserts both local sync and frame sync to video signal C via sync add circuit 220B and frame sync circuit 380B in order to synchronize it with the currently displayed video signal A, which is still being provided from the upper digital video buffer 230A. At the appropriate switch point, triggered by programming codes supplied with each video signal A and C, the microprocessor 260 directs the VBI switch 335 to switch in the vertical blanking interval from video A to video C, at which time video C will then seamlessly appear on the computer screen.

Digital video buffers 230A, 230B may be used in the circuit of Figure 3, but are optional. However, in an alternative embodiment the buffers would be required to provide a seamless switch if the Figure 3 circuit was modified to incorporate a single RF demodulator 200, single forward error corrector 205, and single digital demultiplexer 210, each with a single input and single output. In this alternative embodiment, the circuit cannot independently receive and demultiplex two data streams on different frequency channels. One buffer 230A is used to store

previously received video signals, while the other buffer 230B quickly passes through the selected video signals.

Based on the same assumptions above, video signal A is progressing through the upper branch of the circuit and it is desired to switch to video signal C. However, in this alternative embodiment, the digital video buffer 230A is providing maximum buffering to video signal A.

Because it is desired to switch to video signal C, the microprocessor 260 directs the alternative circuit (containing a single RF receiver 200, single forward error corrector 205 and single digital demultiplexer 210 connected in serial), to receive and demultiplex the data stream on which video signal C is located, which may be different than that of video signal A. When video signal C is demultiplexed, the microprocessor 260 directs the digital video buffer 230 to provide minimum buffering of video signal C so that decompressor/decoder 215 may quickly decompress and decode the digital signals. After decompression and decoding, video signal C is synchronized with video signal A. At this time, video signal A is read for display from digital video buffer 230A. The upper digital video buffer 230A must be large enough to provide video frames for output during the time it takes the RF demodulator 200 and digital demultiplexer 210 to switch to video signal C and the time required for decompression, decoding, and synchronization of video signal C.

When video signal C is synchronized with video signal A, the microprocessor 260 directs VBI switch 335 to switch from video signal A to video signal C in the vertical blanking interval of video signal A, thereby providing a seamless and flicker-free switch.

At this time, digital video buffer 230 will begin to utilize maximum buffering by altering its fill/empty rate as described above with respect to the Figure 3 embodiment. When adequate buffering is achieved, a switch to another video signal may be performed in the same manner as described above.

Another preferred embodiment is shown in Figure 4. This embodiment also includes an RF demodulator 200, a forward error corrector 205, and a digital demultiplexer 210. However, the circuitry differs along the rest of the chain to the television set or monitor. In this embodiment, a memory 475 is incorporated and connected to the output of the demultiplexer for storing the compressed composite digital video signal. The decompressor/decoder 215 is inserted at the output of the compressed memory. The decompressor/decoder 215 decompresses the digital signal, converts the signal to analog and forwards the analog signal to the RF encode 245 for transmission to the monitor. Once the composite compressed digital video signal is fed into the compressed memory 475, the microprocessor 260 directs a pointer to be placed somewhere along the compressed digital video signal. Based on the placement of the pointer, different frames and different segments of the

composite digital video signal will be read from memory 475 for decompression and decoding.

The different video signals are distinguished from one another because they are labeled, preferably by headers. Assuming that video signal A has been selected for play on the monitor, the compressed digital memory 475 fills up with A frames. Assuming a switch to video signal C is desired, the microprocessor 260 directs the RF demodulator 200 and digital demultiplexer 210 to begin filling the compressed memory 475 with video C frames. The decoder 215 pointer begins to move down. As soon as a sufficient number of C frames have entered the compressed memory 475, the pointer will then jump to the beginning of the C frames. The C frames are then output into the decompressor/decoder 215 where the digital frames are converted into an analog signal.

The digital video is multiplexed in a series of easily identifiable packets. These packets may contain full compressed frames of video (I frames) or may include only the differences between full frames (B frames or P frames).

To be able to reconstruct the full video images, the decompressor/decoder 215 needs to have a minimum number of I, P and B frames. The decoder 215 needs only one I frame to decode an image. Conversely, two prior Anchor frames ("I's" and "P's") are necessary to decode B frames. In order to decode P frames, the decoder 215 only needs one Prior Anchor frame. When the microprocessor instructs the digital demultiplexer 210 to start sending packets from a different data stream there is no

way to be certain that the next packet will be an I packet needed for decoding the second video stream. To avoid a breakup of the video images, which would occur if the decompressor/decoder 215 suddenly started receiving packets unrelated to the stream it was decoding, the microprocessor 260 starts to fill up the memory 475 with video signal C packets until it is determined that a full sequence of I, B and P frames are available. The decoder 215 should receive the last bit of the last B frame in a given, GOP (Group of Pictures) before the switch, in order to prevent glitches when decoding. Furthermore, the last B frame of the GOP must only be backward predicted, not forward predicted or bidirectional predicted. As soon as the valid sequence is in memory 475 the microprocessor 260 moves the memory read pointer to the start of a valid sequence of C video signal packets so that the decompressor/decoder 215 can successfully decode the C signals. This results in a seamless switch from video signal A to video signal C.

This embodiment requires a data channel for enabling a synchronous switch between a first video stream and a second video stream. This data channel comprises the ACTV codes which link together the different program elements and information segments on the different video signals. In addition, the data channel also comprises synchronization pulses and a time code to signify to the pointer the proper time to skip from a memory location representing one video signal to a memory location representing another video signal in order to enable a seamless switch.

The microprocessor 260 reads the data signal from the digital demultiplexer 210 and communicates pertinent data to the sync add circuit 220, which is connected to sync generator 225. The microprocessor 260 is then able to synchronously communicate with the memory 475.

The time code sent will identify the timing for one picture, as well as for multiple pictures, and will lock the different pictures together. This is done through the use of similar clocks at both the transmission end and the receiver. A time code is used in order to keep the two clocks at both the transmission and receive end synchronously connected to one another. Once the clocks at both ends are working synchronously, each of the multiplexed video streams must be synchronized to the clocks. In order to synchronize the multiplexed video stream to the clocks, each of the individual channels must be referenced to a common reference point and must be identified.

In the preferred embodiment, a packet header would be incorporated into the transport layer of the MPEG signal to identify the various channels. The packet header will also include information as to where to insert the vertical blanking interval. In MPEG, the vertical blanking interval is not transmitted from the headend. Therefore, the vertical blanking interval must be generated locally. The packet header eye will identify at what time the vertical blanking interval is in existence in order to effectuate a seamless switch between analog pictures.

In summary, the combination of clock and the information embedded in either the transport layer of MPEG or in a separate packet on a separate data channel effectuates the linking between each video signal and a corresponding time point. The data channel also includes information designating when all the various video signals will be in synchronism with one another. It is at these points that the microprocessor 260 may direct the pointer to skip from one location to another location, at a time (such as during the VBI) when a seamless switch will result.

D. Trigger Points

Interactivity is further enhanced in the digital interactive embodiments through the application of trigger points 500 scattered at various predetermined times throughout the program, a timeline representation of which is shown in Figure 5. The trigger points 500 correspond to times when interactive events are scheduled to take place during the live sporting event 10. These interactive events could be the selection and playing of video, audio segments, the display of graphics or display of Web pages accessed from Internet Web sites 170. For example, when a viewer's favorite baseball player is at bat, graphics showing past or current performance statistics of the player can be overlaid on the screen while excerpts from an interview with the player can be played for the viewer. While the choice of particular video, audio or graphics is still dependent on viewer selections, the viewer selections in response to displayed graphical interrogatory messages are

preferably made during a period at the onset of the program or when a viewer first tunes into the program. Alternatively, interrogatories are not necessary if the switches are based on the viewer profile stored in memory 265. These viewer selections are then utilized as inputs to macros called up at later times during the program by the controller 260 upon the occurrence of the trigger points 500, identified to the interactive computer by unique codes embedded in the video signal.

The trigger points 500 correspond to the times when the conventional program content can be altered and personalized for the viewers. The programmer can place the trigger points 500 at any time throughout the program. Since the trigger points 500 are unknown to the subscriber, the subscriber does not know when they will receive a personalized message. In other words, an interactive response can either immediately follow a corresponding user selection made to an interrogatory message or occur at a later time corresponding to a trigger point 500, or any combination of the two. Of course, timing of the interactive events should correspond to suitable times in the program where branching to interactive elements is sensible and does not clash with the program content of the conventional video still displayed on the television 165 or other display monitor.

At the onset of a trigger point 500, the controller 260 will select one of several possible audio (or video or graphic display) responses for presentation to the

subscriber. As mentioned above and shown in figure 5, some of the responses may comprise a branch to either a video segment, graphics and/or audio segments.

In combination with the use of trigger points 500, the present invention allows for the viewer to select certain options at the onset of the program to suit the viewers' preferences. For example, if the program broadcast is a live sports event 10, at an early trigger point 500, the viewer could be queried as to whether the viewer would prefer to receive audio in English, Spanish, French, or perhaps hear the local announcer instead of the network announcer. Upon the viewer selection, the CPU 260 directs a branch to the appropriate interactive segment.

Each trigger point 500 is identified preferably through the broadcast of ACTV codes sent as part of the composite interactive program signal. The codes preferably include, at a minimum, the following information: (1) header identifying the occurrence of a trigger point 500; (2) function ID (e.g., selection of audio or graphics responses, etc.); and (3) corresponding interrogatory message(s) or particular viewer characteristic or habit based on viewer profile. The first bit sequence simply identifies to the controller that a trigger point 500 is about to occur. The function ID designates the macro or other set of executable instructions for the controller 260 to read and interpret to obtain the desired result, e.g., a selected video and/or audio response.

Upon extraction of the codes by the data decoder, the controller 260 reads and interprets the codes and calls from memory 265 a particular user selection(s)

designated by the trigger point 500 codes. The user selections correspond to subscriber answers to a series of interrogatory messages preferably presented at the beginning of the program. After obtaining the appropriate user selection(s), the controller 260 reads and performs the executable instructions using the user selection(s) as input(s) in the macro algorithm. The result of the algorithm is either a selected video stream, audio and/or selected graphics response. The video/audio response can be called from memory 265 if it is prestored, called from external data storage, or the controller 260 can command the switch to branch to the particular video audio stream if the response is broadcast concurrently with the trigger point 500. After the selected video/audio response is played to the subscriber, the switch branches back to the standard program, shown at time t_s in Figure 5.

As mentioned above, a series of interrogatory messages are preferably presented when the subscriber begins watching the interactive program. These interrogatory messages can be presented in any one of three ways. First, the interrogatory messages can be presented as graphics displays overlaid by the interactive computer workstation onto a video signal, wherein the graphics data is sent in the vertical blanking interval of the composite interactive signal, or alternatively stored on the hard disk or external storage. Second, the interrogatory messages are presented as graphics displays as discussed above, except the graphics data comes from local storage, external data storage (e.g., CD ROM, cartridge, etc.), or a combination of data in the VBI and data called from either local or external data

storage. Third, graphics data can be presented in the form of user templates stored at the interactive computer workstation.

User selections corresponding to answers to the n successive interrogatory messages are received by the remote interface 270 at the beginning of the show, stored in memory 265 and used throughout the show at the appropriate trigger points 500 to subtly change program content as the show progresses. Preferably, each interrogatory has a set of possible answers. Next to each possible answer will be some identifier corresponding to a label on a key on the user interface. The subscriber depresses the key corresponding to their answer selection. This selection is decoded by the remote interface 270 and controller 260, stored in memory 265, preferably RAM, and used later as required by an algorithm designated at a trigger point 500.

E. Internet

In addition to the central studio serving as a source of interactive option responses, the Internet can be used as a source of personalized information for interactive responses.

As discussed above, the video programming is preferably created at a centralized location, i.e., the control studio 5 as shown in Figure 1, for distribution to subscribers in their homes. Referring to Figures 1 and 6, in a preferred method, the operator at the control studio 5 must designate certain Web pages to correspond to

one of the program options, such as audio and/or graphics options, using control PC 135 and URL encoder 600. Instead of encoding the actual content of the options at the control studio 5, as with the audio, Web address identifiers, i.e., Uniform Resource Locators (URLs) are encoded and sent as part of the data codes from the control PC 135 to the digital multiplexer 140. After multiplexing, the URLs are sent as part of the program signal 615, as described above. Preferably, the URLs, like the various audio and graphics options, have associated time stamps which indicate to the remote digital set top boxes 25 when, during the video program, to display the particular Web pages addressed by the URLs, the selection and display of which is preferably made as a function of viewer responses or viewer profile.

Preferably, each digital set top box 25 has an Internet connection 160 created concurrently with the cable connection. The Internet connection 160 can be via high-speed line, RF, conventional modem. The digital set top box 25 has Internet access 160 via any of the current ASCII software mechanisms. In a preferred embodiment, in the interactive digital set top box 25, the digital demultiplexer 210 extracts the URLs along with the other data codes. In an alternative embodiment, a local URL decoder 605 at the user site extracts the URLs.

In a preferred embodiment, a JAVA enabled browser as well as specialized software for performing part of the method of the present invention are installed on the interactive digital set top box 25. The JAVA enabled browser allows the interactive digital set top box 25 to retrieve the Web pages and is preferred software,

since it is platform independent, and thus, enables efficient and flexible transfer of programs, images, etc., over the Internet. The specialized software acts as an interface between the video programming and the Internet functions of the present invention. The processor and software interprets these URLs and directs the JAVA enabled browser to retrieve the particular relevant Web pages, and synchronizes the retrieved Web pages to the video content for display on the television monitor 165 at the appropriate times.

In the present invention, the viewer also has the capability to link to a channel website at will. For example, if a viewer is interested in purchasing a product described in an advertisement, by merely clicking on a button on their remote 20, the producer's Website could be accessed by Internet connection 160 and displayed to the viewer. The viewer could then either obtain more information about the product or order the product, if desired. As described above, this application is possible by sending the URL associated with the producer's Website to the digital cable boxes 25 as part of the interactive program. Upon selection by the viewer, the web browser, located either in the digital set-top box 25 or externally in a connected PC 610, can retrieve the Web pages. The specialized software then synchronizes the Web pages for video display.

F. Memory

The interactive digital set top box 25 of the present invention also has the advantage of remembering subscriber responses and using these responses in choosing a video/audio response, and/or graphics interrogatory message, to present to the student. Memory branching is a technique of the present invention where the algorithm assembles video/audio responses and graphics interrogatory messages according to the current and previous user inputs. Memory branching is accomplished by linking video/audio streams and/or successive graphics interrogatory messages together in a logical relationship. In this scheme, the interactive digital set top box 25 contains logic (preferably, in the software algorithm) and memory 265 to store previous subscriber selections and to process these previous responses in the algorithm to control future video/audio stream selection, as well as future graphics message selection.

G. Digital Viewer Profiles

In a preferred embodiment, the interactive digital cable box 25 can have a "viewer profile" stored in its memory 265. Alternatively, the accumulated profile of viewer characteristics and/or habits can be stored at the control studio 5 or cable headend. If the profile statistics are accumulated at some central location, they can also be sent to each viewer's home. On the other hand, if accumulated in memory 265 at each of the set top terminals 25, the data could be sent to the central location

for storage and dissemination by way of the digital back channel. Decisions regarding personalized advertising and viewing can then be made for a viewer or class of viewers based on the accumulated parameters.

The "viewer profile" preferably contains characteristics of the particular viewer at that subscriber location, such as sex, hobbies, interests, etc. This viewer profile is created by having the viewer respond to a series of questions.

Alternatively, the viewer profiles could be created at a control studio 5 and sent to the interactive digital cable box 25. This information is then used by the cable box software to create a compendium of the viewer's interests and preferences -- i.e., a user profile. The stored user profile would be used in place of the question/answer format, and thus, dictate the branches to interactive segments of interest to the viewer.

Alternatively, the interactive cable box 25 can be programmed to create a user profile of each viewer based on the selections made during one of the interactive programs. If the profile shows that a particular viewer does not enjoy violence, the system can automatically branch to another video signal at the commencement of a fight in a sports program. Furthermore, such a user profile could be modified or enriched over time based on selections made during future interactive programs. For example, the 'memory' technique described above can be used to modify the user profile based on user response over time.

Event data is collected from the viewer when the following command is received and processed by the controller 260 in the interactive digital cable box 25:

VIEWER PROFILE

This command is used to enable events which can be utilized for profiling during a show. The events indicated in this command are those profiling events which are possible during the show. The enabled events may be either selected by the viewer during the show, or may be automatically enabled based upon viewer selections.

VIEWER_PROFILE EVENT1,...EVENT24

Once the profile is created, the programming choices or interactive responses can be triggered based on the content of the viewer profile itself. For example, if the viewer profile suggests that the viewer is particularly interested in sports cars, a sports car commercial could be played for the viewer at a predetermined point in the program. As another application, if a viewer's profile indicates that the viewer is interested in cooking, whenever the viewer watches such a program, the user profile would trigger the interactive program to download recipes and either display such recipes on the screen or send the recipes to an attached printer.

Viewer profile information can then be collected at the control studio 5 through polling of the viewer cable boxes 25 for viewer selection data. Special polling software is loaded into the digital set top box 25 for performing the polling functions. Alternatively, the invention allows for the digital set top boxes 25 to send

back data on command from the control studio 5 or periodically. The command to initiate an upload of viewer profile data is as follows:

UPLOAD EXTENDED

This command is used to initiate the uploading of data to the central site.

**UPLOAD_EXTENDED UPLOAD_IDENTIFIER VARIABLE_NAME
[PHONE_NUMBER]**

**UPLOAD_IDENTIFIER
VARIABLE_NAME
PHONE_NUMBER**

numeric constant identifying upload.
name of variable to be uploaded
string, that consists of numbers only.
it can be omitted, if not needed.

Regardless of whether a polling or periodic scheme is used, the statistics and other user profile information is preferably sent back to the control studio 5 by use of the back-channel.

H. Applications

The embodiments, described above, allow for several possible applications. For example, in a live sports event 10, one channel could carry the standard video channel, with other channels carrying different camera angles 100 and/or close-ups of particular players. Other potential video options include instant replay, highlights, player statistics via graphic overlays, etc. Graphics presenting statistical information on the players can be constantly updated using the Chyron system.

The provision of trigger points 500, explained above, can provide for seamless integration of such video options during the sporting event, based on either the viewer responses to interrogatories at the beginning of the program and/or on the digital viewer profile.

Further, the viewer can become the director with the present invention. For example, the viewer can choose which camera angles 100 to emphasize. In a broadcast of golf, the viewer can direct whether they desire to follow a particular player from hole-to-hole, focus on one particularly difficult hole. In this manner, the viewer can customize the sporting broadcast to meet his own interests.

Further, the viewer can act as a director to create their own video. During a live concert 10, for example, the viewer selects various camera angles 100 at different times. These selections along with a time stamp, indicating the program time when each selection was made, are stored in memory 265. When the program is played back a second time, the processor 260 will automatically direct branching between the video channels according to the stored selections at the time stamp. In this manner, a music video can be created by the viewer.

The viewing experience can be further enlightening for the viewer by implementing games and contests during the live sporting event 10. For example, graphics overlays can be developed that query the viewer during the game. During a football broadcast, for example, viewers can be queried with such interrogatories as the following:

What will be the next play? (RUN/PASS/KICK);

Will the offense get the first down?;

Will they score on this possession?;

Pick the halftime score;

Who will win?

Each viewer's responses can be sent back to the control studio 5 for tabulation of scores. Preferably, the responses are packaged at the digital cable box 25 and transmitted to the control studio 5 via the digital backchannel upon the *UPLOAD EXTENDED* command. Alternatively, tabulation of scores can take place at the digital cable box 25 through the utilization of certain software in memory 265. Each correct answer can correspond to a certain number of points. At the end of the game, the interactive program preferably presents a graphic showing the viewer point total. If desired, advertisers could present special gift certificates for excellent performance in such games. The provision of such certificates would occur by displaying a certain code that a viewer can take to a store to receive the gift. In this manner, viewer interests in sports events can be enhanced.

Further, the viewer has the option with the present invention to block out viewing of certain events. For example, if the viewer is adverse to violence during a sporting event or other type program, the system can block out such options from the viewer with the following data commands:

EVENT

This command is used to indicate occurrence of a certain event (e.g., a fight breaking out during a football game).

EVENT EVENT_NUMBER

EVENT_NUMBER is a numeric constant.

ON EVENT EXECUTE MACRO

This command is used to implement certain actions (such as an automatic branch to another video channel in order to block out violent event, for example), as soon as the event arrives.

ON_EVENT EVENT_NUMBER MACRO_NUMBER

EVENT_NUMBER is a numeric constant.

MACRO_NUMBER is a numeric constant.

I. Two-Way Configuration

The live programming system of the present invention may be operated in a two way configuration, as illustrated in Figure 7. In this mode, the various video signals are processed as previously described, being digitized and compressed at the control studio 5. The signals are then sent to a central switching station, or headend 30.

In this embodiment, the switching between the various live digital signals is accomplished at the headend 30 rather than at the receiver. On the receive end, each digital set-top box 760 relays viewer selections back to the remotely located

switching station 30. Preferably, the viewer selections are relayed by way of the digital back channel 770. However, the viewer selections may be relayed to the switching station 30 by any conventional means, such as two-way cable television, telephone or microwave transmission. The switching station 30 receives the viewer selection and routes the desired signal to a transmitter 750 which conventionally transmits the desired video down the appropriate digital cable channel for the particular viewer.

At the central switching station 30, a demultiplexer 710 demultiplexes the compressed signals and places each on a separate bus channel 725. A number of remote control interactive switches 730, 732, 734, 736 are connected to the video signal bus 725. Based on the viewer selections, an algorithm stored in memory 265 and under processor 260 control at the central switching station 30, a digital seamless switch is made and the selected video, audio and/or graphics are forwarded to the viewer home for display.

Such a two-way embodiment could be implemented in a video dial tone or video server system. In such a system, only a single video channel 755 is necessary for each home. Once the viewer selection is received at the server site at the cable headend 30, a switch is made to the appropriate video stream and this stream is sent on the single channel 755 to the home.

Alternatively, it may be desirable to transmit an interactive sporting event over a single telephone line. When the viewer enters a selection on their remote

20, a signal is sent by way of the telephone line to the central switching station 30 which routes the desired signal of the interactive program over the user's telephone line so that a single link handles both the interactive choice being made at the receiver and the transmission of that choice from the headend 30 where the actual switching takes place in response to the interactive selection made at the receiver.

The two-way link between the viewer and switching station 30 may be used for other purposes. For example, demographic data may be transferred from the viewer to the broadcast network for commercial purposes, such as targeted advertising, billing, or other commercial or non-commercial purposes.

While the present invention has been described primarily with respect to live events, and in particular sporting events, it has equal potential for enhancing content in other program categories. A viewer can become their own director of a murder mystery or other drama. By entering responses to displayed questions at the initiation of or during the show, the program will branch to alternative video/audio segments as a result of the user selections. In this manner, different viewers with different selections may end up with a different murderer at the conclusion of the broadcast.

Using the foregoing embodiments, methods and processes, the interactive multimedia computer maximizes personalized attention and interactivity to subscribers in their homes in real time. Although the present invention has been described in detail with respect to certain embodiments and examples, variations and modifications exist which are within the scope of the present invention as defined in the following claims.